Paper presented in the IV Globelics Conference at Mexico City, September 22-24 2008

Globelics

An investigation on the contribution of universities and research institutes for maturing the Brazilian innovation system: PRELIMINARY RESULTS[1]

EDUARDO ALBUQUERQUE (*******&)
WILSON SUZIGAN (*)
SÍLVIO CÁRIO (**)
ANA CRISTINA FERNANDES (***)
WALTER SHIMA (****)
JORGE BRITTO (*****)
ACHYLES BARCELOS (******)
MÁRCIA SIQUEIRA RAPINI (********)

INTRODUCTION

The positive feedbacks between science and technology are decisive features of mature innovation systems (Cohen et al, 2002). The literature on National Systems of Innovation (NSI) and on recent successful catch up processes suggests that universities and research institutes can make very important contributions to development (Mazzoleni & Nelson, 2007; UNIDO, 2005). These contributions are associated with the emergence of patterns of interactions between these components of NSI and business enterprises, whereby knowledge flows in both directions. These two-way interactive relationships

[1] The authors thank Soraia S. M. Carvalho, Pietro Antunes, Fabio Silva Neto, Thiago Rodarte, Isabel Moura and Vanessa Parreiras for their research assistance. The authors acknowledge the key contributions from Herica Righi, Alexandre Stamford, Janaína Ruffoni Trez, Wellington Cruz, João Furtdo, Renato Garcia, Marcelo Pinho and Catari Vilela Chaves for this research. Participants in four national seminars (São Paulo, July 2006; Belo Horizonte, May 2007, Araraquara, August 2007 and São Paulo, February 2008) contributed to shape this research.

(*******&) CEDEPLAR-UFMG, albuquer@cedeplar.ufmg.br
(*) IGE-UNICAMP, wsuzigan@ige.unicamp.br
(**) UFSC, fecario@yahoo.com.br
(***) UFPE, anacf.ufpe@gmail.com
(****) UFPR, waltershima@ufpr.br
(*****) UFF, jbrit@terra.com.br
(******) UNISINOS, achylesbc@unisinos.br
(********) IE-UFRJ, CEDEPLAR-UFMG, msrapini@cedeplar.ufmg.br

promote virtuous circles in the production and diffusion of knowledge in both the scientific and technological dimensions.

Current research on university-industry linkages (henceforth, UILs) throughout catch up process indicates that the "modes of interaction" between universities/research institutes and firms change as the country develops (Eun et al, 2006). The dynamic relationship between these two key components of a NSI reflects the co-evolution of factors such as the research capabilities of universities and research institutes on the one hand, and the absorptive capacity of firms on the other. These factors define different "modes of interaction" and their changes over time.

In the case of Latin American countries, the interactions described above do not seem to be working fully. Anecdotal evidence, case studies, and a limited amount of statistical data indicate that, while some firms are indeed benefiting from their contacts with universities and public labs, for the most part there is little fruitful interaction. This is limited to a handful of different business sectors. But while one can see areas of fruitful interaction between university and industry, these seem the exception not the rule.

This paper investigates the academic side of the university-industry linkages, reporting PRELIMINARY results from a survey applied to research groups from universities and public institutes in Brazil. This version is very descriptive, and the discussions during Globelics will help to improve the analysis of these data and to shape a more elaborated version of this research report.

As the focus is the academic side, from this standpoint the survey allows us to investigate issues like the nature of these interactions, their sophistication, how they differ across different science and engineering fields and across different industrial sectors. A very important issue is also to inquire about how research groups located in universities and public research institutes may benefit from these interactions with firms and other institutions.

I- BACKGROUND: INTERACTIONS IN IMMATURE NSIs AND IN BRAZIL

There is a huge literature on the role of universities in developed countries ("mature NSIs"): Mowery & Sampat (2004) present a very broad review of this literature. There are also excellent discussions on the role of universities throughout successful catching up processes: Mazzoleni & Nelson (2007) and Mazzoleni (2005) are important contributions to this subject. This paper would like to investigate the role of universities in a different set of countries, focusing in an “immature” NSI, Brazil (other immature NSIs would be, probably, India, Mexico and South Africa).[2]

Immature NSIs seem to be under a permanent risk of “falling behind”; therefore it is not effortless to stay in the same place. This effort to avoid a “falling behind” is a precondition for a successful catch up process, a process that demands that a country “must run at least twice as fast as that!” And large countries as Brazil, India, Mexico and South Africa certainly require a lot of additional energy to run faster.

Universities and public labs might have an important role in the effort to avoid the risks of “falling behind”. This paper conjectures that partial connections (between firms and universities) already operating in immature NSIs contribute to this effort. This conjecture informs the investigation on interactions between universities and firms in immature NSIs.

The interactions between science and technology are important since the beginning of development process. These interactions, however, have different features vis-à-vis already developed countries. The investigation of the specific and peculiar nature of this interaction begins with a discussion about the specific role for science in less developed countries. The starting point is a review of the literature on economics of technology and its criticisms of views that underplay the efforts necessary for technological imitation. Silverberg (1990, p. 179) shows how imitation and diffusion of technologies must be seen as a continuation of the innovative process. This effort to imitate depends on internal capabilities: initial stages of development and catching up process depend on “absorptive capability”.

Beyond their key role as supporting the absorptive capability, the scientific institutions have other important contributions for development: 1) a "focusing device" in this process, working as an “antenna” for the creation of links with international sources of technology; 2) the national scientific capability is a major support for industrial development, providing the knowledge necessary for the entry in key industries for the

[2] This paper uses the term “immature” NSIs for idiosyncratic reasons. This term is compatible with other interpretations, as Viotti (2002). An immature NSI may be identified by exclusion, as countries in an intermediate level of development. They are not neither among developed countries, nor among catching up, nor among countries with only rudiments of innovation system (Albuquerque, 2003).

process of development; 3) there is a causal relationship chain between improvements in the scientific dimension and consequent improvements in health, which by its turn, leads to more economic growth; 4) there is a causal link between science and agricultural improvements, because technologies created in more developed countries “cannot be transferred from one zone to another merely through tinkering” (UNDP, 2001, p. 96); 5) assuming that imitation is the initial form of local innovation, it is unavoidable a huge effort to adapt technologies to a new environment (in terms of income, weather, demography and epidemiology).

The investigation of specificities of immature NSIs has brought evidences on the stage of present interactions between science and technology. Rapini (1997) searches for matches between firms (by ISIC sectors), and Research Groups (by S&E fields) and finds the following spots of interaction: Agriculture (ISIC sector)-Agronomy (S&E field); Mining-Geosciences; Pulp & Paper-Forest Engineering; Machinery-Mechanical Engineering; Electric & Electronic Equipment-Electric Engineering; Metallurgy-Materials and Metallurgic Engineering; Chemicals-Chemical Engineering.

These data suggest that to survive even in low and in medium tech sectors as mining, pulp and paper, iron and steel, agro-food etc, the role of universities and public research institutes should not be underestimated. This may hint an important contribution of universities to avoid a “falling behind” process.

These partial connections and the process of establishment of interactive, although localized, relationships between firms and universities have complex historical roots (see Suzigan et al, 2008).

Hence a reasonable diagnosis of Brazil’s situation under this heading would indicate the existence of a “pattern of university-firms interaction” characterized only by localized “points of interaction” between the scientific and technological dimensions. Rapini (2007) identifies this localized and scattered configuration in successful cases of linkages between universities and/or research institutions, and firms. A description of these cases (e.g. Paula e Silva, 2007; Morel, 1999) contributes to an understanding of the historical origins of the institutions and the interaction process that structures the linkages concerned.

Generally speaking, a long historical process of learning and accumulation of scientific knowledge and technological competencies involving significant linkages between productive effort, government, and research and education institutions lies behind all Brazilian products with comparative advantages in the international market. The most important of these include the following, with the respective knowledge areas and research institutions involving interaction:

(1) in health sciences — production of serums and vaccines (Oswaldo Cruz Institute, Butantan Institute);

(2) in agrarian sciences — cotton, forests for paper pulp, grains, meats (IAC, Embrapa);

(3) in mining, materials engineering and metallurgy — production of ores, steels and special metal alloys (UFMG);

(4) in aeronautical engineering — aircraft production by Embraer (CTA and ITA);

(5) in geosciences — oil and gas production by Petrobras (COPPE-UFRJ, Unicamp).[3]

Despite the importance of these products and knowledge areas, it would be no exaggeration to say that the "pattern of interactions" identified is fairly limited and still insufficient to impart to the economy as a whole a dynamic of growth based on the strengthening of the nation's innovative capacity.

There are institutions created "ahead of an industrial demand": 1) Escola de Minas (Carvalho, 2002; Mazzoleni & Nelson, 2007) and 2) Instituto Tecnológico da Aeronáutica. These institutes were clearly in the "disconnection" side of the system for a long while.

The existence of these two processes of institution-formation indicates a difference with the endogenous nature of American universities, according to Rosenberg (2000).[4]

Furthermore, as Mazzoleni & Nelson (2007) comment the role of "the user community" necessarily with "strong incentives to improve their practices, and the capability to use what is coming out of the research program". This capability depends

[3] There are many other important instances, especially from the regional standpoint, such as the production of fuel alcohol in São Paulo State and Rio de Janeiro State and in the Northeast; electric motors and turbines in Santa Catarina, with the Federal University of Santa Catarina (UFSC) playing an important role; and cocoa processing and textile manufacturing in Bahia, supported by the Institute of Industrial Chemistry, successor to the Bahia Institute of Agriculture (founded in 1857), among others.

[4] Carvalho (2002, p. 22 and p. 66) stresses this difference between Brazil and USA. Rosenberg (2000) argues that size matters in the case of US university system and in their relationship with industrial sector. Mazzoleni (2005) presents data that show how the US forged ahead in the numbers of university students vis-à-vis even their European counterparts. Bernardes & Albuquerque (2003) show a threshold level for a more pervasive interactive behavior from firms and universities, and that immature NSIs are below this "critical mass" level.

upon firms' resources and R&D investments are decisive to understand and to monitor what universities are doing.

This comment is an additional indication that it is not easy the formation of these two-way flows between firms and universities. Therefore existing partial connections are very important and precious for immature NSIs. That is why this paper investigates them.

II- UNIVERSITIES, INTERACTIVE RESEARCH GROUPS AND FIRMS

The CNPq Directory of Research Groups is a project developed by CNPq since 1992 to gather and organize information regarding research activities in Brazil. The concept of research group is: a group of researchers, students and technical support staff that is organized around the execution of scientific research lines following a hierarchical rule based in the expertise and in the technical-scientific competence. The group members usually share facilities and physical location.

The database information are related to human resources (researcher, students, technicians), research lines, knowledge specificities, the sectors of active involved, scientific, technological and artistic participant's production and patterns of interactions with productive sector. The unit of investigation in CNPq's Directory is the research group that is space (institution, federal state and region) and time located (CNPq, 2005).

The CNPq Directory gathers information from public universities (federal, state and municipal); private universities; higher education institutions (non-universities) with at least one formal graduated course; public scientific research institutes; public technology institutes; R&D laboratories from state owned enterprises; non-governmental organizations (NGOs) permanently involved in scientific or technology research. Private enterprises from industrial sector are not included in this Directory.

Since 2002 the CNPq questionnaire introduces specific questions about their interactions with firms and institutions. These answers are an important source of information of university-industry interactions in Brazil. However, it is important to notice that there is an underestimation of the interactive level declared by the research group leader, as identified in Rapini (2004). This underestimation problem remains in the Census 2004.[5] This underestimation should be kept in mind throughout this paper.

The adherence to Directory is spontaneous even though researchers have been increasingly stimulated to participate, principally to have access to public finance for scientific research. The Directory universe is increasing during the years and now it covers a representative part of the national scientific community (Carneiro and Lourenço, 2003).

The information from research groups is available in CNPq website (http://lattes.cnpq.br/) and can be obtained in two forms: current database and census database. The Census is a biannual static snapshot from the current database.

Census's information for this paper is obtained in a module that permits a quantitative picture of the research in Brazil ("Plano Tabular"). The system offers the possibility to cross variables and to generate a variety of tables. For this work, the unit of investigation is a research group. Looking at research groups the investigation may identify the existence (or not) of interactions with firms/institutions. The available variables are: 1) the research groups science and engineering fields; 2) firms/institution that they interact with; 3) types of relationship.

Until now there are six Censuses: 1993, 1995, 1997, 2000, 2002 and 2004. In the first version, there were 99 institutions and 4,402 research groups. In the 2004 version, which is used in this paper, there are 375 institutions and 19,470 research groups.

Table 1 shows the distribution of research groups, total and interactive[6], by Brazilian states (ranked by the number of interactive research groups). The distribution of total groups reproduces national inequalities as identified before, being São Paulo the leader with 5,541.

Table 1:
Research Groups (total and interactive groups) by states, ranked by Interactive Research Groups, and Firms/Institutions that interact with these Groups, Brazil, 2004

[5] Conversations with research group leaders provided evidence about this general underestimation. These researchers explain that the questionnaire is time consuming, sometimes their answers are incomplete.
[6] Interactive research groups are those that their leaders (the questionnaire respondents) declared at least one relationship with firms/institutions.

States	Groups (a)	Interactive Groups (b)	Firms/ Institutions (c)
São Paulo	5,541	464	746
Rio Grande do Sul	2,072	265	417
Rio de Janeiro	2,786	259	329
Minas Gerais	1,694	226	367
Paraná	1,512	183	347
Santa Catarina	996	163	290
Bahia	728	111	163
Pernambuco	602	87	149
Distrito Federal	477	61	98
Ceará	423	52	82
Pará	286	52	57
Goiás	266	43	75
Paraíba	329	36	46
Amazonas	289	28	24
Rio Grande do Norte	220	24	40
Mato Grosso	171	19	28
Espírito Santo	200	16	28
Sergipe	105	15	15
Maranhão	119	14	16
Mato Grosso do Sul	225	11	13
Alagoas	133	10	12
Tocantins	97	6	8
Piauí	101	3	18
Roraima	30	2	2
Acre	25	1	6
Amapa	10	0	0
Rondônia	33	0	0
Total	**19,470**	**2,151**	**2,768**

Source: CNPq Directory of Research Groups, 2004, author's elaboration

Table 1 shows the modest proportion of interactive research groups: 2,151 out of 19,470 (11% of all) groups reported interactions (therefore, it seems to exist a large room for improvement). Even in the leading state (São Paulo), only 8.4% of research groups are interactive.[7]

Table 2 presents the distribution of research groups according to S&E fields (ranked by the number of interactive research groups). There are 76 S&E fields. Although Medicine has 1,257 research groups, it ranks in the eighth position in regard to interactive groups. There is a puzzle here, already pointed by Rapini (2004). Highlighting the Brazilian specialization in S&E fields, Agronomy leads in terms of interactive groups (186 interactive research groups),[8] and Materials and Metallurgic Engineering leads in terms of the number of firms/institutions with interactions (283 firms/institutions). Engineering fields display an important role, with 5 fields out of the 10 leading fields in Table 2.

Table 2 also indicates that there is not a direct relation between groups and firms/institutions, suggesting to the existence of different interactivity levels among different S&E fields. In this regard, Materials and Metallurgic Engineering has the lead, with 35.8% of its Research Groups declaring interactions, followed by Mechanical Engineering (32.0%) and Electrical Engineering (29.5%) (Righi, 2005, p. 22).

[7] The data for São Paulo may be stro ngly underestimated.
[8] Albuquerque (2004, p. 773) indicates the leading position of “Agriculture/Agronomy” in a ranking of scientific disciplines. The remaining leading disciplines are in health-related fields.

Table 2:

Research Groups (total and interactive groups) by Science & Engineering Fields, ranked by Interactive Research Groups, and Firms/Institutions that interact with these Groups
Brazil, 2004.

Science & Engineering Fields	Groups (a)	Interactive Groups (b)	Firms/ Institutions (c)
Agronomy	793	186	263
Electrical Engineering	447	132	232
Computer Sciences	548	101	162
Civil Engineering	377	100	225
Materials and Metallurgic Engineering	274	98	283
Chemistry	818	94	131
Mechanical Engineering	278	89	176
Medicine	1,257	84	89
Geosciences	477	83	131
Chemical Engineering	226	59	114
Food Science and Technology	297	57	142
Veterinary	340	55	78
Production Engineering	219	54	185
Ecology	339	51	106
Zootechny	261	49	98
Forestry Engineering	130	45	90
Business Administration	492	41	89
Education	1,194	41	58
Sanitary Engineering	143	39	82
Pharmacy	245	34	49
Physics	637	34	49
Others (1)	9678	625	1043
Totals	**19,470**	**2,151**	**3,875**

Source: CNPq Directory of Research Groups, Census 2004, author's elaboration
(1) There are 55 more S&E Fields

Table 2 also shows a large room for improvement. Although the relative importance of the leading interactive groups is greater, vis-à-vis the overall picture, even an applied S&E field as Agronomy has only 23.5% of research groups reporting interactions. Among the leading S&E fields, Electrical Engineering reaches 29.5%, Computer sciences 18.4% and Civil Engineering 26.5%.

III- METHODOLOGY: THE UNIVERSITY SURVEY

The organization of the university survey involves two steps.

The **first step** is the construction of a database from the CNPq's Directory of Research Groups embracing all research groups with interactions with firms and other institutions. CNPq's Directory of Research Groups gathers information from public and private universities, public scientific research institutes and public technology institutes (Rapini, 2007). In Census 2004 there were in Brazil 375 universities and research institutions and 19,470 research groups. This Directory, since Census 2002, has information about the interactions established between these research groups and firms and other institutions. In 2004, 2,151 research groups had interactions with 3,875 firms and institutions. These 2,151 interactive research groups and the correspondent 3,875 firms and institutions constitute our database.

The **second step** is the implementation of a survey with these 2,151 interactive research groups. The preparation of the questionnaire for this survey involved a long and lively discussion between participants from different states in Brazil, a Latin American Workshop to design and improve it, and e-mail exchanges between the Asian and African groups involved in similar investigations.

The questionnaire involves some key questions about the nature of the interactions with firms and other institutions: 1- types of relationship; 2- results from the interaction; 3- benefits for the university group; 4- difficulties with the interactions and; 5- channels of information flow from group towards firms. Furthermore, the questionnaire investigates how the researcher differentiates the relations with firms according to its industrial sector its size, and whether or not it had an R and D operation of its own. Finally, there are general questions to explore such aspects of these relationships as their impact on the group's research output and activities (eg, papers, dissertations), or the origins of the initiative that led to their interactions.

An online version of the questionnaire was designed by our research team. The link to the questionnaire was sent to each of 2,151 group's leader in an email invitation to participate and collaborate in the research. The email sending task was divided between eight regional teams and each team was responsible for contacting research groups belonging to universities located in their state or region. The email sending effort was enlarged by phone calls to group's leader in other to reach a higher number of answers. This step of the research started in April 4th and until 8th of July we received answers from 723 research groups, located in 24 Brazilian states. These 723 research groups interacted with 1,376 firms/institutions.

IV- PRELIMINARY RESULTS: GENERAL INFORMATION

Table 3 presents summarizes the data related to these 723 research groups and 1,376 firms/institutions.

Regarding the research groups, "agronomy" is the S&E field with more answers (62), followed by "material and metallurgy engineering" (42 groups), "mechanic engineering" (38 groups), "electrical engineering" (38 groups), "computing sciences" (32 groups), "civil engineering" (32 groups), "medicine" and "chemistry (with 24 groups) and "geosciences" (with 22 groups). These 9 S&E fields (out of 70 fields) represent 44% of the identified research groups.

Regarding the firms/institutions, 1,145 could be identified in terms of ISIC sector and size. The option is to preserve data from interaction with ISIC sectors beyond mining and manufacturing, as Table 3 shows. "Manufacturing" has 281 firms, "agriculture" 53 firms, "mining" 21 firms, "electricity" 53 firms, "information and communication" 41 firms, "health and social work" 48 institutions, "public administration" 80 institutions.

Table 3 displays the interactions between S&E fields and ISIC sectors, according to the point of view of the academic side of these interactions. Each matrix cell shows the interaction between a S&E field and an ISIC sector. Each matrix cell presents the number of research groups and the number of firms/institutions in the interaction, according to the 2004 data.

Table 3 shows 27 “points of interaction”. “Material and metallurgy engineering” (11 “points of interaction”) and “Agronomy” (6 points of interaction) are the main S&E fields in this regard. “Computing sciences”, “Electrical engineering” and “Forest Engineering” follow with 2 points of interaction each. Finally, “food science and technology”, “civil engineering”, “chemical engineering”, and “medicine” have one point of interaction each.

Table III: ISIC sectors and Science & Engineering Fields, by Research Groups and Firms with interaction, Brazil. 2004/2008.

ISIC Economic Sector	Agronomy	Biochemistry	Comp Science	Food S&T	Ecology	Ph. Education	Nursing	Aerospace Eng	Agric. Eng	Biomed Eng.	Civil Eng.	Mat, Metal Eng	Mining Eng.	Prod. Eng.	Electrical Eng.	Mechanical Eng.	Nuclear Eng.	Chemical Eng.	Sanitary Eng.	Pharmacy	Pharmacology	Physics	Genetics	Geosciences	Medicine	Veterinary	Microbiology	Oceanography	Dentistry	Other Areas of Bio Sciences	Other Areas of Health Care	Prob and Stats	Chemistry	Forest Res. & Eng	Fishery Res. & Eng	Public Health	Zoology	Zootechny	Humanities	Firms' Total
Agriculture, livestock, forestry, fishing and aquaculture	15/18	1/1	2/2	1/2	1/1	0/0	0/0	0/0	1/1	0/0	1/1	3/3	0/0	1/1	0/0	3/1	0/0	1/1	0/0	0/0	0/0	0/0	2/2	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	11/12	3/4	0/0	1/1	6/7	0/0	58
Extractive industries	1/1	0/0	1/1	1/1	0/0	0/0	0/0	0/0	0/0	0/0	1/1	3/3	3/3	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	5/5	0/0	0/0	0/0	1/1	0/0	0/0	0/0	0/0	1/1	4/4	0/0	0/0	0/0	0/0	0/0	21
Manufacturing	16/25	5/6	10/16	11/23	3/3	1/9	0/0	4/6	11/11	5/7	13/23	32/213	4/7	9/22	16/30	24/46	1/1	14/35	4/5	6/9	5/8	6/10	3/6	3/3	7/8	8/8	2/6	1/1	8/8	4/4	2/2	1/1	17/36	16/26	2/3	0/0	3/3	7/12	7/13	655
Manuf. of food products	8/12	1/1	1/1	8/14	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1/1	0/0	3/2	1/1	0/0	0/0	5/6	0/0	1/1	1/1	0/0	1/1	0/0	0/0	1/2	1/1	0/0	1/1	2/1	0/0	0/0	0/0	1/1	1/2	0/0	1/1	3/5	1/1	56
Manuf. of beverages	1/2	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1/1	1/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	4
Manuf. of tobacco products	0/0	0/0	0/0	1/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1
Manuf. of textiles	0/0	0/0	0/0	0/0	0/0	1/1	0/0	0/0	0/0	0/0	2/2	1/2	0/0	0/0	0/0	0/0	0/0	1/2	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1/1	0/0	0/0	0/0	0/0	1/1	0/0	9
Manuf. of wearing apparel and accessories	1/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	2
Tanning and dressing of leather; manuf. of luggage and footwear	0/0	0/0	0/0	0/0	0/0	1/6	0/0	0/0	0/0	0/0	0/0	1/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	8
Manuf. of wood	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	2/2	1/1	0/0	0/0	1/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	3/2	0/0	0/0	0/0	0/0	0/0	6
Manuf. of paper and paper products	2/2	0/0	0/0	0/0	1/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1/1	0/0	0/0	0/0	2/2	0/0	0/0	0/0	0/0	1/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	2/2	14/17	0/0	0/0	0/0	0/0	1/1	27
Manuf. of coke, refined petroleum products and biofuel	0/0	0/0	0/0	0/0	1/1	0/0	0/0	0/0	1/1	0/0	0/0	3/3	1/1	0/0	1/1	1/1	0/0	1/1	1/1	0/0	0/0	0/0	2/2	2/2	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	14
Manuf. of chemicals	4/5	1/1	0/0	0/0	1/1	1/1	0/0	2/2	0/0	0/0	0/0	7/28	1/3	2/2	0/0	6/7	0/0	8/16	2/2	1/1	1/1	2/2	1/1	1/1	1/1	0/0	1/1	0/0	2/2	0/0	0/0	0/0	10/11	2/2	1/1	0/0	1/1	1/1	1/2	95
Manuf. of pharmachemical and pharmaceutical products	0/0	3/4	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	2/2	0/0	0/0	0/0	1/1	0/0	1/1	0/0	5/7	3/6	0/0	1/1	0/0	2/4	6/5	1/4	0/0	0/0	2/3	1/1	0/0	3/3	0/0	0/0	0/0	0/0	4/5	2/2	49
Manuf. of rubber and plastic products	0/0	0/0	0/0	1/1	0/0	0/0	0/0	0/0	0/0	0/0	2/3	3/30	0/0	1/1	0/0	2/2	0/0	0/0	2/2	0/0	0/0	0/0	0/0	0/0	0/0	1/1	0/0	0/0	0/0	0/0	0/0	0/0	1/1	0/0	0/0	0/0	0/0	0/0	0/0	41
Manuf. of other non-metallic mineral products	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	3/4	9/43	1/1	0/0	0/0	2/2	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1/1	0/0	0/0	0/0	0/0	0/0	0/0	51
Metallurgy	1/1	0/0	0/0	1/1	0/0	0/0	0/0	0/0	0/0	0/0	4/5	13/20	1/1	2/2	1/2	7/7	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	2/3	1/1	0/0	0/0	0/0	0/0	0/0	41
Manuf. of fabricated metal products, exept machinery and equipment	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1/1	0/0	0/0	2/2	6/12	0/0	3/3	0/0	7/7	0/0	1/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1/1	0/0	0/0	0/0	0/0	0/0	0/0	27
Manuf. of computing equipment, eletronic and optical products	0/0	0/0	8/12	0/0	0/0	0/0	0/0	0/0	2/2	3/3	0/0	3/6	0/0	1/1	11/15	1/1	1/1	0/0	0/0	0/0	0/0	1/1	0/0	0/0	0/0	0/0	0/0	1/1	0/0	0/0	1/1	0/0	2/2	0/0	0/0	0/0	0/0	0/0	1/1	47
Manuf. of electrical machinery and apparatus	1/1	0/0	2/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1/1	3/10	0/0	0/0	5/6	4/4	0/0	0/0	0/0	0/0	0/0	1/1	0/0	0/0	1/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	2/2	0/0	0/0	0/0	0/0	0/0	2/2	29
Manuf. of machinery and equipament	0/0	0/0	1/1	3/6	0/0	0/0	0/0	1/1	4/8	0/0	2/2	6/16	0/0	3/6	1/1	5/7	0/0	4/4	0/0	0/0	0/0	2/2	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	2/3	0/0	0/0	0/0	0/0	0/0	0/0	57
Manuf. of motor vehicles and related	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	8/22	0/0	2/2	1/1	8/6	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1/1	0/0	0/0	0/0	1/1	0/0	1/1	34
Manuf. of other transport equipment, except motor vehicles	1/1	0/0	1/1	0/0	0/0	0/0	0/0	3/2	0/0	0/0	0/0	1/1	0/0	0/0	0/0	2/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	6
Manuf. of furniture	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1
Manuf. of various products	0/0	0/0	0/0	0/0	0/0	1/1	0/0	0/0	0/0	3/4	1/1	3/12	0/0	1/1	2/2	0/0	0/0	0/0	0/0	0/0	0/0	3/4	0/0	0/0	3/2	0/0	0/0	0/0	5/5	0/0	0/0	0/0	2/6	0/0	0/0	0/0	0/0	0/0	1/4	42
Maintenance, repair and mounting of machinery and equipament	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	2/3	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	3
Eletricity and gas	1/1	0/0	2/1	0/0	5/3	0/0	0/0	1/1	1/1	0/0	1/2	1/1	0/0	1/1	13/23	8/10	2/1	0/0	1/1	0/0	0/0	0/0	1/1	2/2	0/0	1/1	0/0	0/0	0/0	1/1	0/0	0/0	2/2	0/0	1/1	0/0	2/3	0/0	7/9	66
Water supply, sewage, refuse disposal and sanitation	1/2	0/0	0/0	0/0	3/3	0/0	0/0	0/0	0/0	0/0	2/2	1/4	0/0	0/0	0/0	1/1	0/0	1/1	3/3	0/0	0/0	0/0	0/0	2/2	0/0	0/0	0/0	0/0	0/0	1/1	0/0	0/0	2/2	0/0	0/0	0/0	0/0	0/0	1/1	22
Construction	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	4/12	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	14
Wholesale and retail trade; repair of motor vehicles, motorcycles	9/10	0/0	4/4	2/2	0/0	1/1	0/0	1/1	5/7	3/2	3/4	5/4	0/0	4/5	2/2	9/11	0/0	2/2	0/0	0/0	1/1	4/4	4/2	1/1	0/0	2/2	1/1	1/1	2/4	1/1	0/0	0/0	1/1	0/0	1/1	0/0	1/1	3/5	5/6	84
Transport, storage and post	0/0	0/0	1/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1/1	1/1	1/1	1/1	1/1	1/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1/1	1/2	11
Housing and food	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1
Information and communications	0/0	0/0	13/20	0/0	0/0	0/0	0/0	1/1	0/0	2/2	1/1	1/1	0/0	3/3	4/5	1/1	0/0	0/0	0/0	0/0	0/0	2/2	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1/1	12/19	56
Financial intermediation: insurance and related services	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	4/7	1/1	1/1	2/2	1/1	2/2	0/0	1/1	0/0	0/0	0/0	1/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	2/1	5/8	26
Real estate, renting and business activities	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1
Professional, scientific and technical activities	13/13	1/1	4/4	4/3	2/2	0/0	1/1	2/2	0/0	0/0	6/3	6/13	2/2	2/2	8/9	7/6	1/1	4/5	1/1	1/1	1/1	2/2	4/4	7/6	2/2	1/1	0/0	6/7	0/0	2/2	1/1	0/0	3/3	5/3	1/1	0/0	1/1	3/4	16/24	131
Administrative and complementary services	3/3	0/0	1/1	1/1	1/1	0/0	0/0	1/1	0/0	0/0	2/5	1/2	0/0	0/0	4/2	1/1	0/0	1/1	0/0	2/2	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1/1	0/0	0/0	0/0	0/0	5/6	27
Public administration and defence; compulsory social security	11/17	0/0	1/2	2/1	1/1	1/1	1/1	1/1	1/1	1/8	1/1	3/4	0/0	1/1	1/1	3/3	3/5	0/0	4/4	0/0	0/0	0/0	2/2	5/7	2/2	3/2	0/0	2/2	1/1	3/3	0/0	1/1	3/4	1/1	1/1	3/4	1/2	1/3	9/15	102
Education	8/14	0/0	1/1	2/2	0/0	2/3	1/1	1/1	0/0	1/2	1/1	3/2	0/0	2/5	1/1	1/1	1/1	0/0	1/1	0/0	0/0	0/0	0/0	3/4	3/2	2/2	1/1	0/0	0/0	0/0	0/0	0/0	1/2	1/1	0/0	1/2	1/1	5/7	14/16	74
Health and social work	0/0	0/0	0/0	0/0	0/0	0/0	1/1	0/0	0/0	3/4	0/0	3/3	0/0	0/0	0/0	1/1	1/1	0/0	0/0	0/0	0/0	4/7	2/2	0/0	16/11	2/2	0/0	0/0	3/4	2/2	0/0	0/0	2/2	1/1	0/0	0/0	0/0	1/1	7/7	49
Recreational, cultural and sporting activities	0/0	0/0	1/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1/2	0/0	0/0	0/0	0/0	0/0	0/0	3
Other service activities	11/18	1/3	3/3	2/2	1/1	1/1	2/3	0/0	2/3	1/1	5/9	4/10	1/2	1/1	1/1	3/4	0/0	1/2	2/2	0/0	0/0	0/0	1/2	2/2	7/7	0/0	0/0	1/1	0/0	0/0	0/0	0/0	1/1	4/8	0/0	2/2	1/1	3/3	16/21	114
Extraterritorial organizations and bodies	0/0	0/0	0/0	0/0	0/0	0/0	1/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1
Total of Research Groups	108	13	57	40	20	10	7	19	28	22	66	141	17	45	68	111	10	50	21	16	12	28	26	33	44	27	7	13	22	19	5	5	64	65	11	6	14	42	115	1370/2169

Search: RP Survey

V- PRELIMINARY RESULTS: CHANNELS OF INFORMATION, BENEFITS, RESULTS AND ORIGIN OF THE INTERACTION

V.1- TYPES OF RELATIONSHIP

Table 4 shows the types of relationship according to their importance to the research groups. The leading types are "consultancy" and "short-term R&D collaborative projects", followed by "training" and "technical evaluations".

Table 4

Types of relationship,

between research groups and firms, according to the importance of that type of relationship to the group's research activities (groups answering important and very important)

Types of relationship,	Moderately or very important	
	Absolute	Relative %
Consultancy	492	68,05
Short-term R&D collaborative projects	492	68,05
Training and courses (for firms' employees)	459	63,49
Technical evaluations, project management	408	56,43
R&D projects that complements innovative activities in firms	395	54,63
Long-term R&D collaborative projects	369	51,04
Temporary personnel exchanges	364	50,35
Technology transfer (licensing)	343	47,44
Tests	286	39,56
R&D projects that substitutes innovative activities in firms	274	37,90
Engineering services	217	30,01
Other	43	5,95

Source: BR Survey

This ranking differs according to S&E fields. The top five S&E fields in terms of questionnaires' answers (Agronomy, Materials and Metallurgy Engineering, Electrical Engineering, Mechanic Engineering, and Computing Sciences) have scored "short-term R&D collaborative projects" as more important than consultancy. On the other hand, the following four S&E fields rank consultancy ahead of "short-term R&D collaborative projects".

According to economic sectors there are differences too: the groups with interactions with manufacturing firms, mining firms and agriculture report “short-term R&D collaborative projects” as more important the “consultancy”, while “public administration”, “health services”, and “other services” rank “consultancy” as more important.

According to firm size, there are minor differences: groups interacting with the smaller (less than 10 employees) and larger firms (more than 500 employees) rank “short-term R&D collaborative projects” slightly ahead of “consultancy”, while groups interacting with firms with size in between these extremes rank consultancy slightly ahead of “short-term R&D collaborative projects”.

Finally, there is a relationship between the number of interactions of one research group and the type of relationship: there are 9 groups interacting with more than 90 firms/institutions. We have contacted these groups to investigate their activities. Their S&E fields are “agronomy”, “materials and metallurgy engineering”, “mechanical engineering”, “transport engineering”, “production engineering”, and “zootechny”. The interactions these groups have with firms are related to “tests” (quality of milk, for instance) “quality control” and even “metrology”.

V.2- RESULTS

Table 5 presents the main results of the interaction, according to the research groups. The five more important results are directly related to academic activities (new research projects, human resources, thesis and dissertations and publications and even scientific discoveries. Between the sixth and eighth positions are results related to the industry (“new products and devices”, “improvements of industrial processes”, and “improvements in industrial products”).

Table 5

Results of interaction with firms, according to the importance of that result to the group's research activities (groups answering important and very important)

Results	Moderately or very important		Most important result *	
	Absolute	Relative %	Absolute	Relative %
New research projects	621	85,89	58	8,02
Human resource and students education	601	83,13	15	2,07
Dissertations	595	82,30	93	12,86
Publications	580	80,22	24	3,32
Scientific discoveries	436	60,30	50	6,92
New products and artifacts	423	58,51	54	7,47
Improvement of industrial process	361	49,93	40	5,53
Improvement of industrial products	344	47,58	26	3,60
Patents	331	45,78	26	3,60
New industrial process	330	45,64	42	5,81
Software	241	33,33	6	0,83
Spin-off firms	185	25,59	7	0,97
Design	142	19,64	1	0,14
Other	14	1,94	3	0,41

Source: BR Survey

*Among the 279 groups (38,54%) didn't choose the most importante result.

One important S&E field with differences in this ranking is “Materials and Metallurgy Engineering”, that ranks “improvements in industrial products” first, followed by “improvements of industrial processes” and “new research projects”.

The ranking presented in Table 5 is not very different according to ISIC sectors or firms/institutions size.

It is important to stress that patents are in the 9^{th} position in Table 5.

Table 5, therefore, shows that the academic production of the research group is strengthened, as a result of the interaction.

V.3- BENEFITS FOR THE GROUP

Table 6 shows how the research groups evaluate their benefits from the interactions. The positive evaluation upon their research efforts is coherent with their evaluation of the results (Table 5). The leading benefits are directly related to research activities per se ("insights for new collaborative research projects", "knowledge or information exchange").

Table 6

Benefits for the group in the interaction with firms, according to the importance of that benefit to the group's research activities (groups answering important and very important)

Beneficts	Moderately or very important		Most Important Benefit*	
	Absolute	Relative %	Absolute	Relative %
New research projects	620	85,75	110	15,21
Insights for new collaborative research projects	589	81,47	65	8,99
Knowledge or information Exchange	589	81,47	98	13,55
Access to new networks	520	71,92	30	4,15
Reputation	506	69,99	16	2,21
Financial resources	500	69,16	63	8,71
Material input for research	496	68,60	36	4,98
Shared access to equipment /instruments	378	52,28	31	4,29
Other	17	2,35	5	0,69

Fonte: Pesquisa de Campo. BR Survey

*Among the 724 groups that responded to the survey 269 (37.15%) did not inform the most important benefit.

The benefits related to financial resources and access to material inputs and equipments are important, but rank in the last three positions.

The leading benefits ranked in Table 6 are the same across S&E fields, ISIC sectors and size.

V.4- CHANNELS OF INFORMATION

Table 7 shows the channels of information for transferring knowledge from the research groups towards firms/institutions. The leading channels are “research contracts”, “publications”, “public conferences and meetings”, “training” and “R&D cooperative projects”. These are channels of information straightly related to the research and teaching roles of universities. “Informal information exchange” is the next leading channel of information.

Table 7

Channels of information between research groups and firms/institutions, according to the importance of that channel of information for transferring knowledge from groups towards firms/institutions.

Channels of information	Moderately or very important		Most important channel of information*	
	Absolute	Relative %	Absolute	Relative %
Research contract	547	75,66	71	9,82
Publications and reports	545	75,38	62	8,58
Public conferences and meetings	544	75,24	45	6,22
Training	513	70,95	17	2,35
R&D cooperative projects	508	70,26	79	10,93
Informal information exchange	482	66,67	17	2,35
Recently hired graduates	423	58,51	12	1,66
Individual consulting	381	52,70	18	2,49
Temporary personnel exchange	376	52,01	10	1,38
Engagement in network with firms	329	45,50	18	2,49
Patents	310	42,88	11	1,52
Science and/or technology parks	292	40,39	7	0,97
Incubator	288	39,83	7	0,97
Licensed technology	280	38,73	4	0,55
Spin-off from universities	268	37,07	19	2,63
Others	16	2,21	4	0,55

Source: BR Survey

*Among the 724 groups that responded to the questionnaire 323 (44,61%) did not inform the most important channel of information.

It is interesting to note how "consultancy" ranks in Table 7: it is in the 8th position. As a "type of relationship" (Table 3), "consultancy" ranked first, but here, as channel of information it is not so important.

Patents, in the 11th position, are not a very important channel of information, according to Table 7.

New channels of interaction, as "engagement in networks with firms", "science and technology parks", "incubators", and "spin-offs" are not very relevant, so far.

According to S&E fields, there are differences in this ranking. For instances, there are important S&E fields that rank "publications" and "public conferences and meetings" as more important channel of information than "research contracts": "agronomy", "civil engineering", "geosciences", "medicine" and "zootechny".

According to ISIC sectors, there are differences in the ranking too. Groups interacting with “Manufacturing” rank “R&D cooperative projects” first, ahead of “public conferences and meetings” and “research contracts”. “Agriculture” ranks “research contracts” first, but ““R&D cooperative projects” second. “Publications” rank first for “Public administration”, “education”, “human health services”, “information and communication” and the manufacturing sector “food”. Groups interacting with “Mining” ranks “public conferences and meetings” and “publications” ahead of “research contracts”.

According to the size of firms/institutions, the ranking also has differences. The research groups working with larger firms (more than 500 employees) score “public conferences and meetings” ahead of “research contracts”. Research groups working with smaller firms/institutions rank the three leading channels of information as in Table 6.

V.5- THE INITIATIVE TO ESTABLISH THE INTERACTION

Table 8 presents the answers to the question “Who did take the initiative to establish the relationship between the research group and the firm?”

The researcher is the origin of initiative in 71% of answers, the firm is in the second position (46% of answers). It is important to note that the group and the firm have shared the initiative in 40.5% of the answers.

Table 8
Who did take the **initiative** to establish the relationship between the research group and the firm.

Origin of the initiative	Number of responders*	Relative Frequency %
The individual researcher	514	70,99
The firm	334	46,13
Both (shared initiative)	293	40,47
The research group	232	32,04
University graduate employed by the firm	152	20,99
University institutional mechanism for technological transfer (office)	77	10,64
A spin-off firm created by former group members	39	5,39
Initiative from an ex-researcher	32	4,42
Others	12	1,66

Source: BR Survey

*In the questionnaire the group could choose more than one option

It is also important to note the limited role of "University institutional mechanism for technological transfer" (only 10.6%) for this topic.

The ranking shown in Table 8 is the same the same across S&E fields, ISIC sectors and size.

VI- STABILITY OF INTERACTIONS, THE PERCEPTIONS OF INTER-FIRM DIFFERENCES, AND UNUSED RESEARCH RESULTS.

Three elements that may help to contextualize the data gathered by this survey are presented in this section.

The first topic is the stability of these interactions. Taking as benchmark the number of firms/institutions that each group reported in 2004 and comparing this number with the number reported in 2008, there are four groups: 1) 364 research groups that have increased the number of interactions; 2) 149 that have the same number of interactions, 3) 90 that have decreased the number of interactions; 4) 103 groups with no interactions in 2008.

This topic deserves a closer investigation. In general, it seems a positive result, indicating that there is a relative stability of these interactions. Only two S&E fields have their research groups interacting with less firms/institutions than previously ("Medicine" and "Parasitology").

The ranking among those four groups is preserved according to ISIC sectors and firms/institutions' size.

The second topic is the existence of unused research results. There are 288 research groups that declared to have research results not used so far by firms/institutions. These answers may be very informative to improve future interactions. Almost half of the research groups in "agronomy", "material and metallurgy engineering", "mechanic engineering", "electrical engineering" and almost one third of the groups in "Computing Sciences" reported unused research outputs.

The third topic is the question on "how relations with firms tended to differ as a function of the industry of the firm, its size, and whether or not it had an R and D operation of its own". In this preliminary analysis we selected only research groups (excluding "humanities") interacting with more than five firms. The answers from 151 groups were analyzed, and 48 groups mentioned no differences in their relations with different firms.

The majority of these research groups ("agronomy" and "engineering" are the leading S&E fields here) have perceptions of differences regarding size and formal R&D department. Almost half of these groups mention the improvement in the relationship with the firm with the R&D department.

More qualified human resources help the firm to take advantage of research results. This higher-qualified resources personnel and formal R&D departments makes the communications with the research group easier, according to these answers. These research groups correlate size and R&D departments: these answers are positive in relation to larger firms because they have R&D departments.

Smaller firms are seen as having some advantages, since they have more informal relationships and an easier access to the relevant information. However, these smaller firms do not understand some research results easily. The lack of formal R&D and qualified resources are the reasons for this disadvantage of smaller firms. Furthermore, these answers mention as another disadvantage of smaller firms the dependence upon external (public) funding for their collaborative activities (and larger firms can use their own resources).

VII- PRELIMINARY CONCLUSIONS AND FURTHER RESEARCH

This working-in-progress paper presents preliminary results from a broader research.

The main most important result is the positive perception of researchers located in universities and public institutes about the impact of these interactions. The positive impact on their research and teaching activities may be highlighted, both as "results" from the interaction and as "benefits" for the research groups. This preliminary result must be later checked with more objective tools, to investigate these positive effects of interaction upon the academic output of research groups.

From the academic side of these interactions, it does matter with what S&E disciplines the group is involved and with what sector the group interact. This is not a surprise, but it is important to stress that these differences are important for an immature NSI.

S&E fields seem to influence differences in “types of relationship”, “channels of information” and “results” of the interactions.

ISIC sectors seem to influence differences in “types of relationship” and “channels of information”.

Size of the firms seems to influence differences “types of relationship” and “channels of information”. According to researchers interacting with several firms, size matters because it is highly correlated with R&D departments, which improve the relationship within collaborative projects.

Finally, these preliminary results shed more light in the intermediary stage of Brazilian NSI, since universities and public institutes are involved both in more sophisticated R&D collaborative projects and in more trivial activities (but important) as tests and quality control. In sum, there is a complex mix of contributions of universities and research institutes. Further research might be able to investigate with detail this complex mix.

REFERENCES

ALBUQUERQUE, E. (2003) Immature systems of innovation: introductory notes about a comparison between South Africa, India, Mexico and Brazil based on science and technology statistics. Rio de Janeiro: *First Globelics Conference* (available at www.globelics.org)

ALBUQUERQUE, E. (2004) Science and technology systems in Less Developed Countries. In: MOED, H.; GLÄNZEL, W.; SCHMOCH, U. (eds) (2004) *Handbook of quantitative science and technology research*. Dordrecht: Kluwer Academic Publishers.

BERNARDES, A.; ALBUQUERQUE, E. (2003) Cross-over, thresholds and the interactions between science and technology: lessons for less-developed countries. *Research Policy*, v. 32, n.5, pp. 867-887.

CARNEIRO, LOURENÇO (2003) Pós-graduação e pesquisa na universidade. In: VIOTTI, E.; MACEDO, M. M. (orgs) *Indicadores de ciência, tecnologia e inovação no Brasil*. Campinas: Editora Unicamp.

CARNEIRO, LOURENÇO (2003) Pós-graduação e pesquisa na universidade. In: VIOTTI, E.; MACEDO, M. M. (orgs) *Indicadores de ciência, tecnologia e inovação no Brasil*. Campinas: Editora Unicamp.

CARVALHO, J. M. (2002) *A Escola de Minas de Ouro Preto*: o peso da glória. Belo Horizonte: Editora da UFMG, 2ª. edição.

COHEN, W.; NELSON, R.; WALSH, J. (2002) Links and impacts: the influence of public R&D on industrial research. *Management Science*, v. 48, n. 1, pp. 1-23.

COHEN, W.; NELSON, R.; WALSH, J. (2002) Links and impacts: the influence of public R&D on industrial research. *Management Science*, v. 48, n. 1, pp. 1-23.

Conselho Nacional de Desenvolvimento Científico e Tecnológico, 2005. Disponível na internet (www.cnpq.br). Acesso em 05 de julho de 2005.

EUN, J-H; LEE, K.; WU, G. (2006) Explainning the university-run-enterprises in China. *Research Policy*, v. 35, pp. 1329-1346.

EUN, J-H; LEE, K.; WU, G. (2006) Explainning the university-run-enterprises in China. *Research Policy*, v. 35, pp.1329-1346.

MAZZOLENI, R. (2005) Historical patterns in the coevolution of higher education, public research and national industrial capabilities. Background paper prepared for UNIDO (2005), Vienna: UNIDO (available at www.unido.org).

MAZZOLENI, R.; NELSON, R. (2007) The Roles of Research at Universities and Public Labs in Economic Catch-up. *Research Policy*, v. 36, n. 10, pp. 1512-1528.

MAZZOLENI, R.; NELSON, R. (2007) The Roles of Research at Universities and Public Labs in Economic Catch-up. *Research Policy*, v. 36, n. 10, pp. 1512-1528.

MOREL, C. (1999) Chagas' disease, from discovery to control – and beyond. *Memárias do Instituto Osvaldo Cruz*, v. 94, Sup. I, pp. 3-16.

MOWERY, D.; SAMPAT, B. (2005) Universities in National Innovation Systems. In: FAGERBERG, J.; MOWERY, D.; NELSON, R. (2005) *The Oxford Handbook of Innovation*. Oxford: Oxford University Press.

PAULA E SILVA, E. M. (2007) A Experiência da Colaboração do Departamento de Engenharia Metalúrgica e de Materiais da UFMG com Empresas – lições para a Lei da Inovação. *Revista Brasileira de Inovação*, v.6, n.2, pp. 433-459.

RAPINI, M. S. (2007) Interação Universidade-Indústria no Brasil: Evidências do Diretório dos Grupos de Pesquisa do CNPq. *Estudos Economicos,*v.37, n.1.

RAPINI, M. S. (2007) Interação Universidade-Indústria no Brasil: Evidências do Diretório dos Grupos de Pesquisa do CNPq. *Estudos Economicos,*v.37, n.1, pp.211-233.

RIGHI, H. (2005) *Interação universidade-empresa em Minas Gerais*: uma análise exploratória a partir do Diretório de Grupos de Pesquisa do CNPq. Monografia de Graduação. Belo Horizonte: FACE-UFMG.

ROSENBERG, N. (2000) *Schumpeter and the endogeneity of technology*: some American perspectives. London: Routledge.

SILVERBERG, G. (1990) Adoption and diffusion of technology as a collective evolutionary process. Freeman, C.; Soete, L. (eds) *New explorations in the economics of technological change*. London: Pinter Publishers, pp. 177-192.

SUZIGAN, W.; ALBUQUERQUE. E. (2008) A Interação entre Universidades e empresas em Perspectiva Histórica no Brasil**.** *Texto para Discussão CEDEPLAR*, n. 329, março.

UNDP (2001) Making new technologies work for human development: Human Development Report 2001. New York: Oxford University (captured at www.undp.org).

UNIDO (2005) *Industrial Development Report*: capability building for catching-up. Vienna: UNIDO.

UNIDO (2005) *Industrial Development Report*: capability building for catching-up. Vienna: UNIDO.

VIOTTI, E.B. (2002). National Learning Systems: A new approach on technological change in late industrialising economies and evidence from the cases of Brazil and South Korea. *Technological Forecasting and Social Change*, 69, n.7, pp. 653-680.